Extraordinarily high conductivity at interfaces of ZrO2:Y2O3/SrTiO3 heterostructures: origin and perspective

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On the origin of the metallic conductivity at the interface of $LaAlO_3/SrTiO_3$

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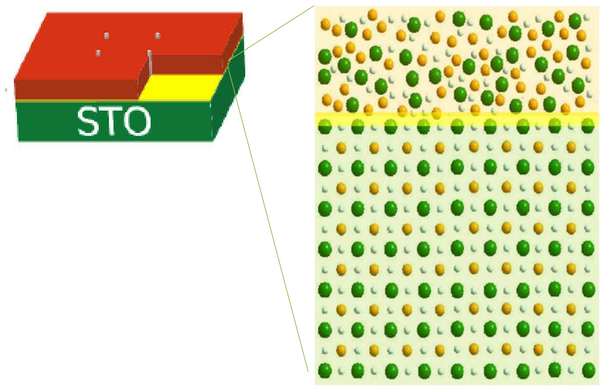
➢Motivation:

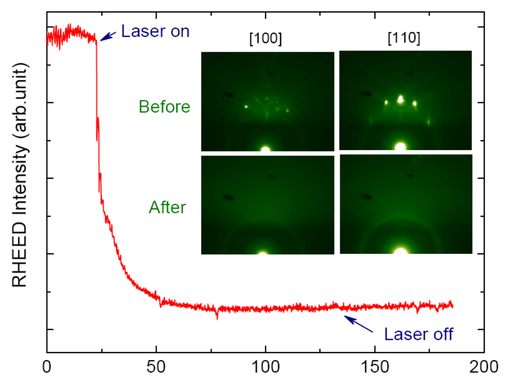
(1) The mechanism underlying the quasi-two-dimensional electron gas (q-2DEG) at the interface between two insulating oxides of $LaAlO_3$ (LAO) and $SrTiO_3$ (STO) remains unclear;

(2) Whether the metallic conductivity exists in LAO/STO hetero-structures if the top LAO films are amorphous, where both polar discontinuity and cation intermixing at the interface are expected to be significantly suppressed.

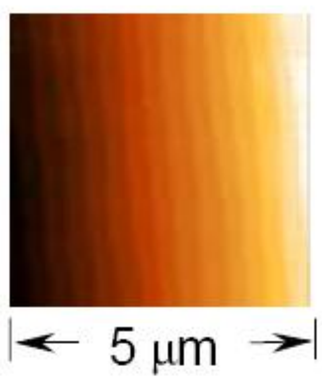
➢ Metallic and insulating interfaces in LAO/STO hetero-structures with amorphous over-layers



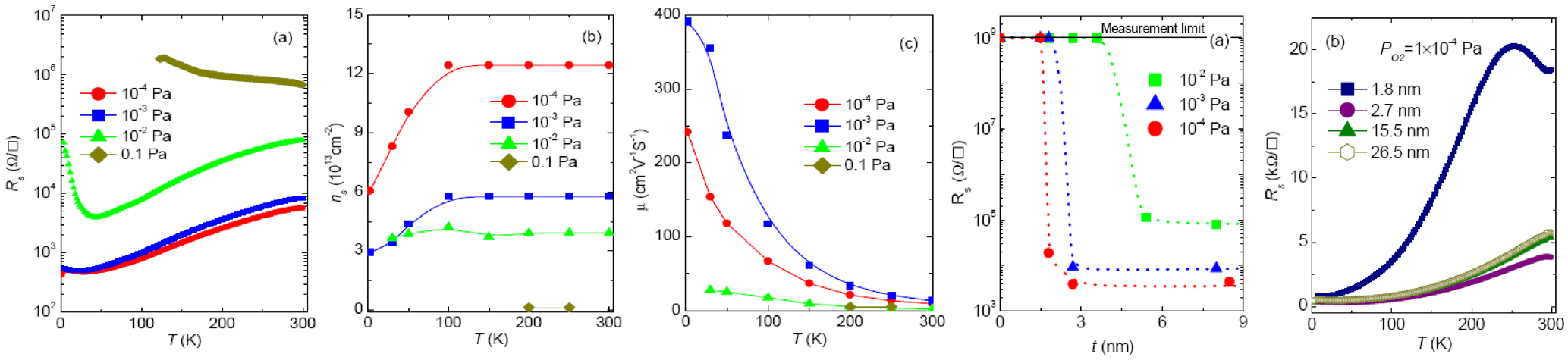
Sketch of the metallic interface



Film growth checked by RHEED

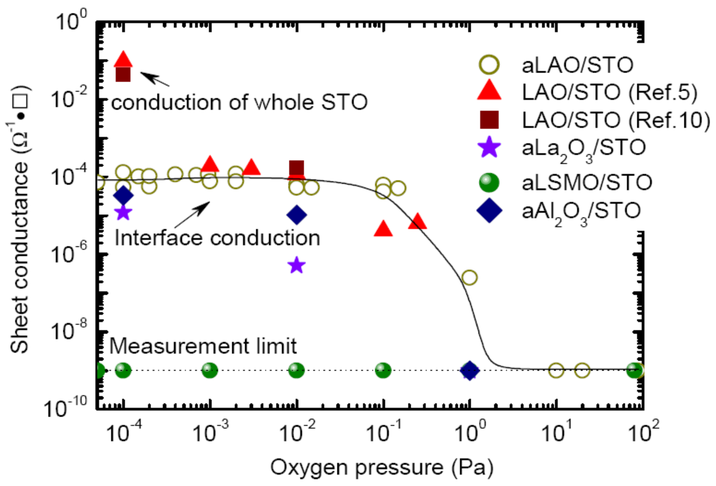


Smooth surface

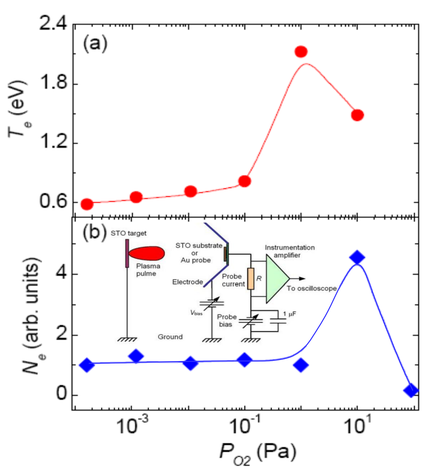


The dependence of the conductivity on the film thickness and oxygen pressure during film growth

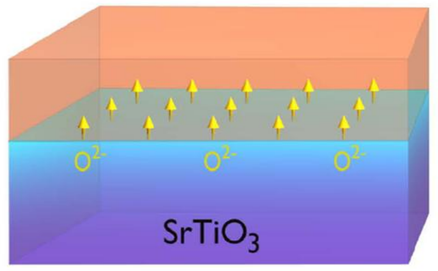
➢Plasma composition related interfacial conductivity in STO-based oxide hetero-structures



Conductivity versus film composition



PLD plasma expansion dynamics



Oxygen ions outward diffusion

Redox reactions on STO surface

➢Conclusion:

1. Metallic interfaces between the STO substrate and various insulating amorphous films of LAO, La_2O_3, or Al_2O_3.
2. Critical dependences of the conductivity on both film thickness and oxygen pressure during film growth.
3. Redox reactions on the STO substrate surface play a important role in determining the conductivity.

➢Relevant papers

1. Y. Z. Chen *et al.* Metal-insulator transitions at interfaces of amorphous $SrTiO_3$-based oxide hetero-structures (submitted).
2. Y. Z. Chen *et al.* Charge-modulated interfacial conductivities in $SrTiO_3$-based oxide hetero-structures (submitted).